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February 1964.

PHOTOGRAPHIC INTERPRETATION REPORT

ELECTRIC POWER GRID IN CENTRAL SIBERIA, USSR,

[redacted]

25X1D

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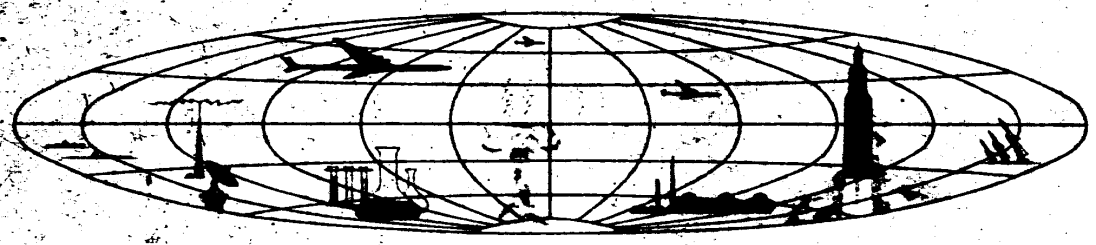

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SUMMARY

Continuing expansion of the power generating and transmitting capabilities of the central Siberian power grid, the eastern half of the Siberian power system, is evident from a survey of all available photography (from KEYHOLE missions since [redacted] 25X1D The photography indicates some modifications to published Soviet circuit diagrams for both installed and planned circuits.

INTRODUCTION 25X1D

This report is in answer to a requirement for a photographic analysis of the availability of electric power in the central Siberian region of the USSR. It is the second in a planned series of photographic interpretation reports on the distribution of electric power in specific areas of the USSR, particularly where installations in an area are supplying power for the Soviet atomic energy program.*

The "Unified National Grid" planned by the Soviets to cover the European USSR also will extend through the Unified Siberian Power System (Yedinaya Energosistema SSR Sibiri) eastward to Lake Baykal. 1 The electric power grid in central Siberia constitutes the eastern half of this unified Siberian power system (Figure 1). The central Siberian region as defined in this report extends north and south of the Trans-Siberian Railroad from 90 to 105 degrees east longitude and includes the major industrial centers of Krasnoyarsk on the Yenisey River and Irkutsk on the Angara River. The power grid of this region serves two atomic energy complexes in the vicinity of Krasnoyarsk (at Dodonovo 2 and Zaozernyy 3) and one in the vicinity of Irkutsk (at Angarsk).

This study is based on an examination of all available KEYHOLE photography through [redacted] covering the region. No TALENT photography or other aerial photography of the area before 1960 is available. Published reports on the atomic energy complexes at Zaozernyy 3 and Angarsk 4 which were based in part on [redacted] photography may revise or update information presented in this report. 25X1D

Although published Soviet circuit diagrams of the unified power system planned for Siberia were available for study, 1 estimates of voltages and numbers of circuits for 500-kilovolt (kv) and 220-kv power lines are generally based on photographic interpretation confirming or revising other data. Estimates for 110-kv circuits are almost entirely based on photographic interpretation.

Atmospheric limitations precluded positive identifications of several electric power installations from photography. For example, all photography of the Krasnoyarsk area was obscured by clouds, haze, or smoke; similarly, the town of Cheremkhovo was obscured by smog. In some cases the plotting of electrical circuits is based on conjecture. The nature of such limiting conditions and the reliability of interpretations are noted on the circuit diagrams (Figures 2-5) and in Table 1 which provides descriptions of the region's power plants.

[redacted]

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ELECTRIC POWER LINES

The central Siberian power grid will eventually be united to the rest of the national grid by extending the Angarsk-to-Nazarovo 500-kv power line west through Novosibirsk and Omsk (Figures 1-5) to the unified system of the European USSR. Within the grid area studied 220-kv power lines will effect major distribution and 110-kv lines paralleling the Trans-Siberian and East Siberian railroads will supply the electrified rail lines and communities along them.

500-kv Power Lines. The first 500-kv power line is currently under construction. When completed it will extend eastward from Nazarovo, the site of a major thermal power plant (Nazarovskaya KES), via Krasnoyarsk, Zaozernyy, and Tayshet, to Bratsk, the site of a large but uncompleted hydroelectric plant

25X9 [redacted]

construction. In some stretches, particularly between Tayshet and Bratsk, the trace for the power line has not been cut and the point where the power line is to cross the Yenisey River in the vicinity of Krasnoyarsk could not be identified.

Other 500-kv lines are planned in the future to link three hydroelectric projects (Yeniseyskaya GES, Boguchanskaya GES, and Ust-Ilimskaya GES) and farther north outside the central Siberian grid to a fourth GES planned near Osinovo on the Yenisey River (Figure 1).

Large 500-kv switching yards were observed at Nazarovskaya KES and Bratskaya GES and 500-kv substations were identified at

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are planned to be located at Tayshet and Kansk. A possible 500-kv substation is identified at Tayshet but one at Kansk has not been identified. A major substation for 220- and 110-kv lines is located at Tulun, but this substation apparently will be bypassed by the two Bratsk-Angarsk 500-kv lines. A site southeast of Tulun which was previously reported as a major substation under construction [5] is reidentified as a cluster of heavy angle supports for 500-, 200-, and 110-kv circuits which change direction at this point. Similarly, a site near Cheremkhovo previously suspect as a substation is reinterpreted as containing only support towers (Figure 5). [5]

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As of [redacted] 500-kv power could not be transmitted over any section of the 550-kv lines. Some 220-kv power was possibly being transmitted over the Nazarovo-Krasnoyarsk and Bratsk-Angarsk sections of the 500-kv line. 25X9
One of the two planned single-circuit 500-kv power lines between Bratsk and [redacted] completed and sections of the second power line were observed under construction as of [redacted] (Figures 4 and 5). [4] While 25X1D
the 500-kv circuits of this line are not yet connected with a 500-kv switching yard at the Bratskaya GES, the completed circuit is temporarily tied into the adjacent 220-kv switching yard at the GES and probably into the 220-kv switching yard of the substation at the Angarsk Atomic Energy Complex.

220-kv Power Lines. In addition to 220-kv power being transmitted over the 500-kv power line (discussed above), single-circuit 220-kv power lines connect Bratsk and Irkutsk in- 25X9

[redacted]

Railroad Power Lines. In the area studied, the Trans-Siberian Railroad is completely electrified between Achinsk, north of Nazarovo, and Slyudyanka along the railroad on the southwestern tip of Lake Baykal. A trace for a new power line is being prepared eastward from Slyudyanka along the railroad on the southern shore of the lake towards Ulan-Ude (Figure 1). The East Siberian Railroad, which branches from the Trans-Siberian Railroad at Tayshet and extends eastward via Bratsk to Lena near Ust-Kut on the Lena River, is also being electrified.

Photography indicates that the Trans-Siberian Railroad is served by a two-circuit 110-kv power line which generally parallels the railroad at a distance averaging about one mile. Both circuits are tied into a number of transformer substations which serve both the railroad and communities along the rail line (Figures 2-5). Between these substations, one of the two circuits is tied into two or three additional, intermediate substations for railroad use basically. In some cases, the names of substations are derived from the official Soviet railway schedule. 8/

The Trans-Siberian Railroad operates under alternating current (ac) between Achinsk and Zima and under direct current (dc) between Zima and Slyudyanka. Transformer substations for ac operations are sited about 35 to 40 miles apart; the transformer/rectifier substations for dc operations are sited approximately 25 miles apart. Substations for dc operations are usually larger in area than those for ac operations and include an ac/dc rectification building of standard size, measuring approximately 1,190 by [redacted] This building also houses an overhead catenary maintenance car. 25X1D

ELECTRIC POWER PLANTS 25X1D

Exploitation of hydroelectric power resources of the Angara and upper Yenisey river basins is a major factor in the plan for the development of electric power in central Siberia. 1 In particular, Soviet engineers appear to be planning to use the Angara River cascade of hydroelectric power plants as a primary power source and to use thermal power plants in the central Siberian area for providing supplementary power and supplying local power needs. This reliance on hydroelectric power contrasts with the usual Soviet practice of relying primarily on thermal generated power and using hydroelectric power for backup. Table 1 provides descriptions of the power plants.

HYDROELECTRIC POWER PLANTS

Of the hydroelectric power plants planned for the central Siberian region, only one (Irkutskaya GES on the Angara) was completed and operational as of [redacted] and one (Bratskaya GES on the Angara) was partially completed and partially operational. Heavy construction had begun on one (Krasnoyarskaya GES on the Yenisey). A possible site for another (Boguchanskaya GES on the Angara) was identified.

Angara Cascade. Reliance on the Angara River as a power source is possible because the river's regime, unlike those of the Yenisey and other major Russian rivers, is characterized by an unusually uniform volume of flow throughout the year. The river's volume of flow is regulated by Lake Baykal which acts as a vast control reservoir. The level of the lake is being raised about 5 feet by the dam for the hydroelectric power plant at Irkutsk.

Photography of Bratskaya GES indicated that four turbogenerators are in operation and that the head of water is at two-thirds of the planned water level. The GES was esti-

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[redacted]

A possible site (58-25N 98-20E) for Boguchanskaya GES 1/ on the lower reaches of the Angara River was identified. Activity resembling geological investigation was observed. A rail line branching off the Trans-Siberian Railroad west of Tayshet at Reshoty was under construction northward toward the site (Figure 1). The rail line will cross the Biryusa River at Shelayevo where a bridge is under construction. Four of six steel spans for the bridge are in place. The right of way for the rail line has been cut northward since [redacted] to a point (57-17N 97-48E) near the Chuna River. The exact site for a railroad bridge to cross this river could not be identified. The rate of construction activity suggests that the rail line will reach the possible site for Boguchanskaya GES sometime in [redacted] Heavy construction on the GES cannot begin until a rail line for transporting heavy construction equipment to the site is completed.

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According to the Soviet press, the site for Ust-Ilimskaya GES has been selected, but the lack of photo coverage up to [redacted] precluded identification of the site. Photography does reveal preliminary construction for either a highway or a railroad extending northward from Novyy Bratsk in the probable direction of the site.

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Yenisey River Development. Soviet plans for exploiting the Yenisey River water resources include construction of the largest GES in central Siberia at a location in the vicinity of Yeniseysk. The site for this GES has not been identified on photography. The second largest, Krasnoyarskaya GES, is observed under construction on the Yenisey upstream from Krasnoyarsk. Foundations are being constructed in the river bed; a rock and earth coffer dam projecting from the left bank of the gorge protects the site. The new community of Divnogorsk, located on the right bank, houses workers employed on the project. Three other hydroelectric projects are planned for the upper reaches of the Yenisey in the vicinities of Minusinsk, Savanskiy, and Chaa-Khol (Bolshaya Tuvinskaya GES).

THERMAL POWER PLANTS

Of major thermal electric power plants in the central Siberian region, four (at Nazarovo, Krasnoyarsk, Zaozernyy, and Angarsk) are at least in partial operation and a fifth major thermal power plant is planned for a location apparently near Azey. All power plants are located near the Trans-Siberian Railroad and are tied to the railroad power line by 110-kv circuits. The on-site power plants at Zaozernyy and Angarsk atomic energy complexes are TETS serving the complexes through internal 110-kv circuits and the power plant at Krasnoyarsk (Krasnoyarskaya KES) serves the Dodonovo atomic energy complex 2/ through 110-kv and probably 220-kv circuits. Two of these power plants--Krasnoyarskaya KES and the Angarsk on-site TETS--are complete (no indication of future expansion) and apparently in full operation.

The Nazarovo power plant and the one planned near Azey are also designated as GRES since they have regional functions. Only the Nazarovo power plant, which when completed will be the largest thermal power plant in the region, will be directly tied to a 500-kv power line. (The on-site TETS at the Zaozernyy and Angarsk atomic energy complexes are indirectly tied--through 110-kv circuits--to the 500-kv line which will service the complexes.) The Nazarovo power plant will also be tied into 220-kv lines; the power plant at Krasnoyarsk is also apparently tied into 220-kv lines.

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At the Nazarovskaya KPS [redacted] one and possibly two turbogenerators were observed in operation and smoke was being emitted from one of the two completed stacks. An addition to the generator hall for at least a third turbogenerator appeared to be completed, and excavation was under way for foundations accommodating possibly three more turbogenerators and their boilers.

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[redacted]

25X9

[redacted]

Other thermal power plants which may or may not be tied into the central Siberian power grid are relatively small. Most of them serve the local needs of communities and installations. Some may generate power for the Trans-Siberian Railroad. These small power plants are listed in Table 1 for information only. In most instances, no photographic interpretation was attempted.

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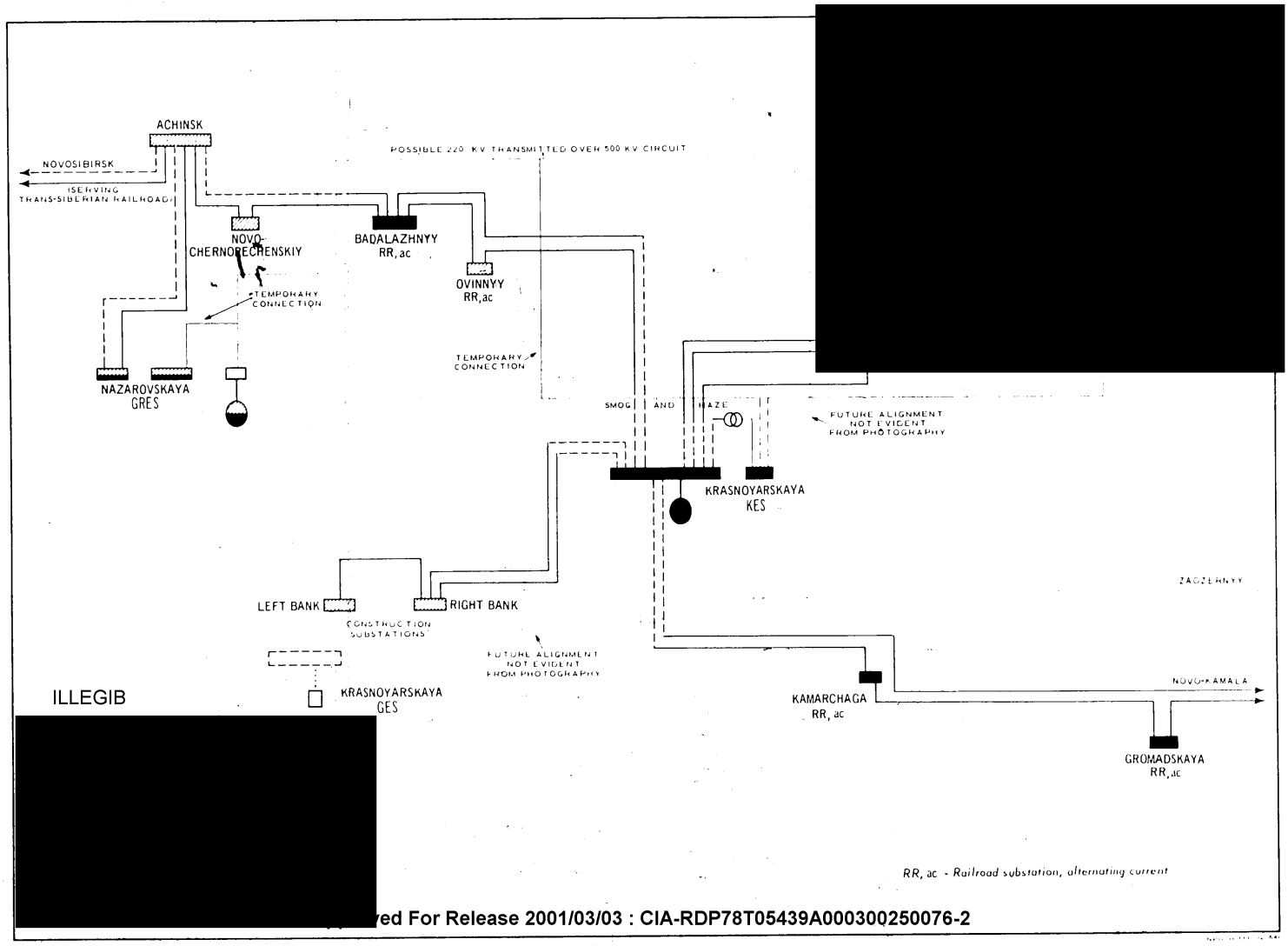

FIGURE 2. WESTERN SECTION OF CENTRAL SIBERIAN POWER GRID. Planned connections outside the grid are not shown.

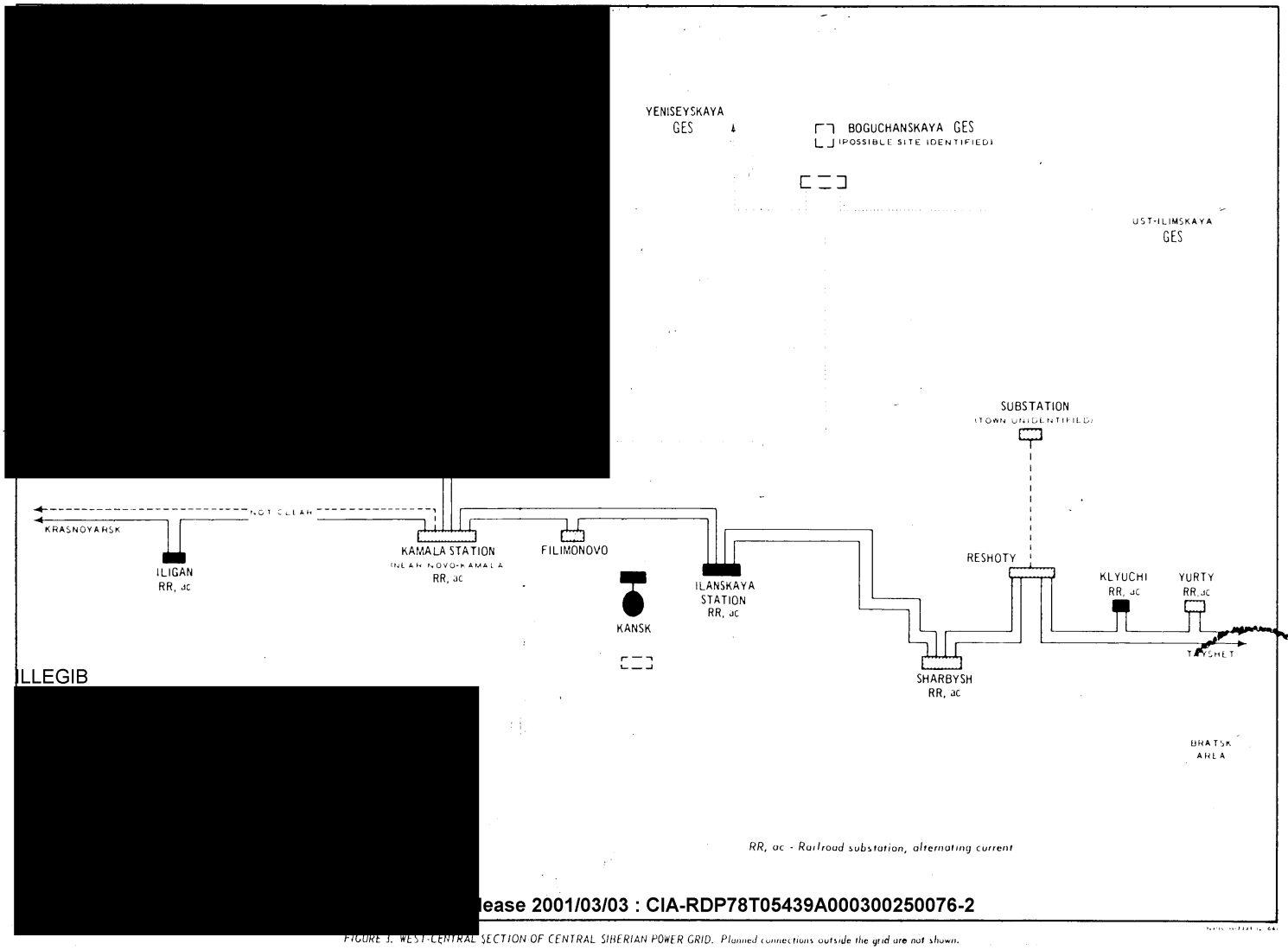

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FIGURE 3. WEST-CENTRAL SECTION OF CENTRAL SIBERIAN POWER GRID. Planned connections outside the grid are not shown.

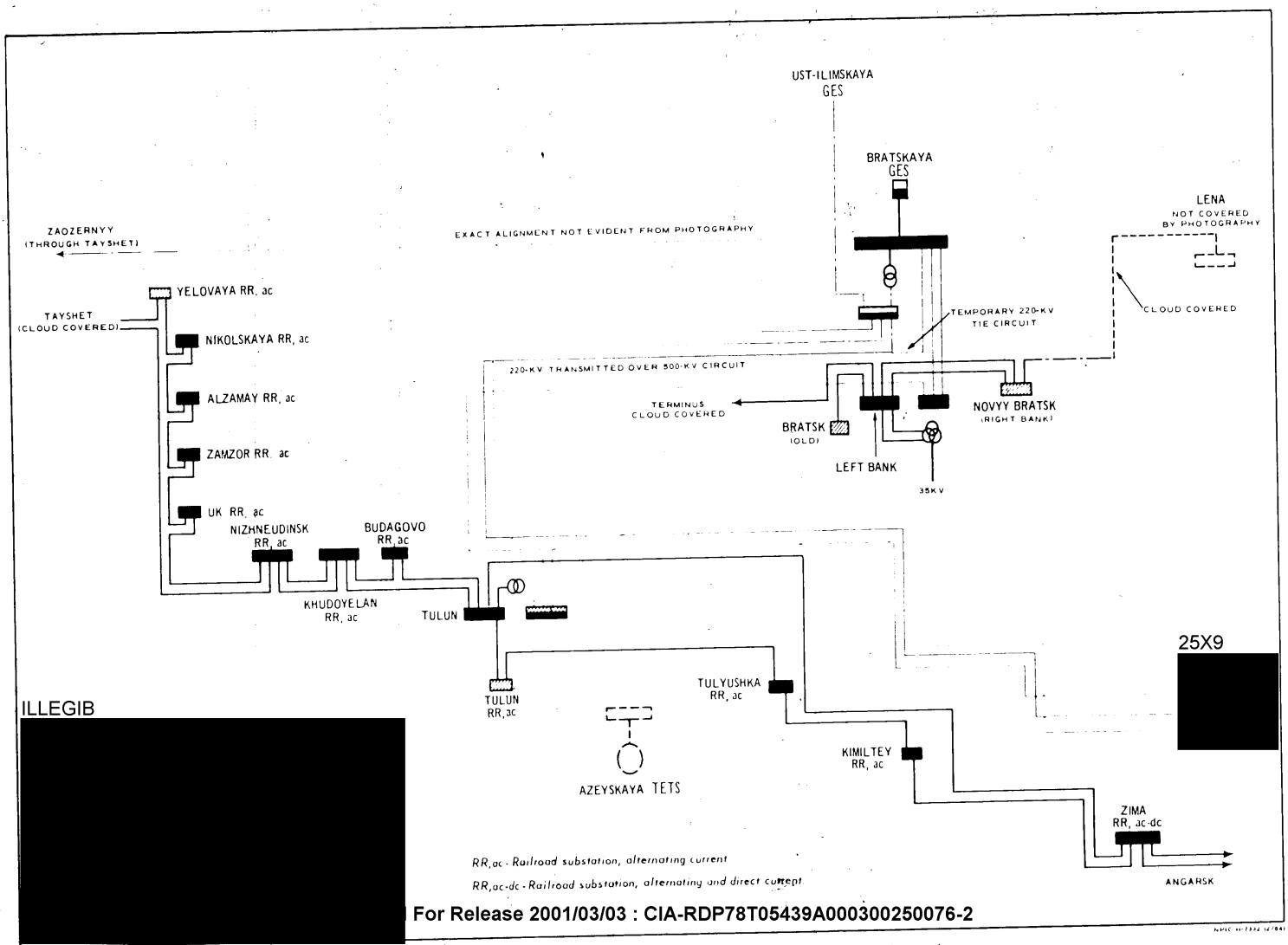

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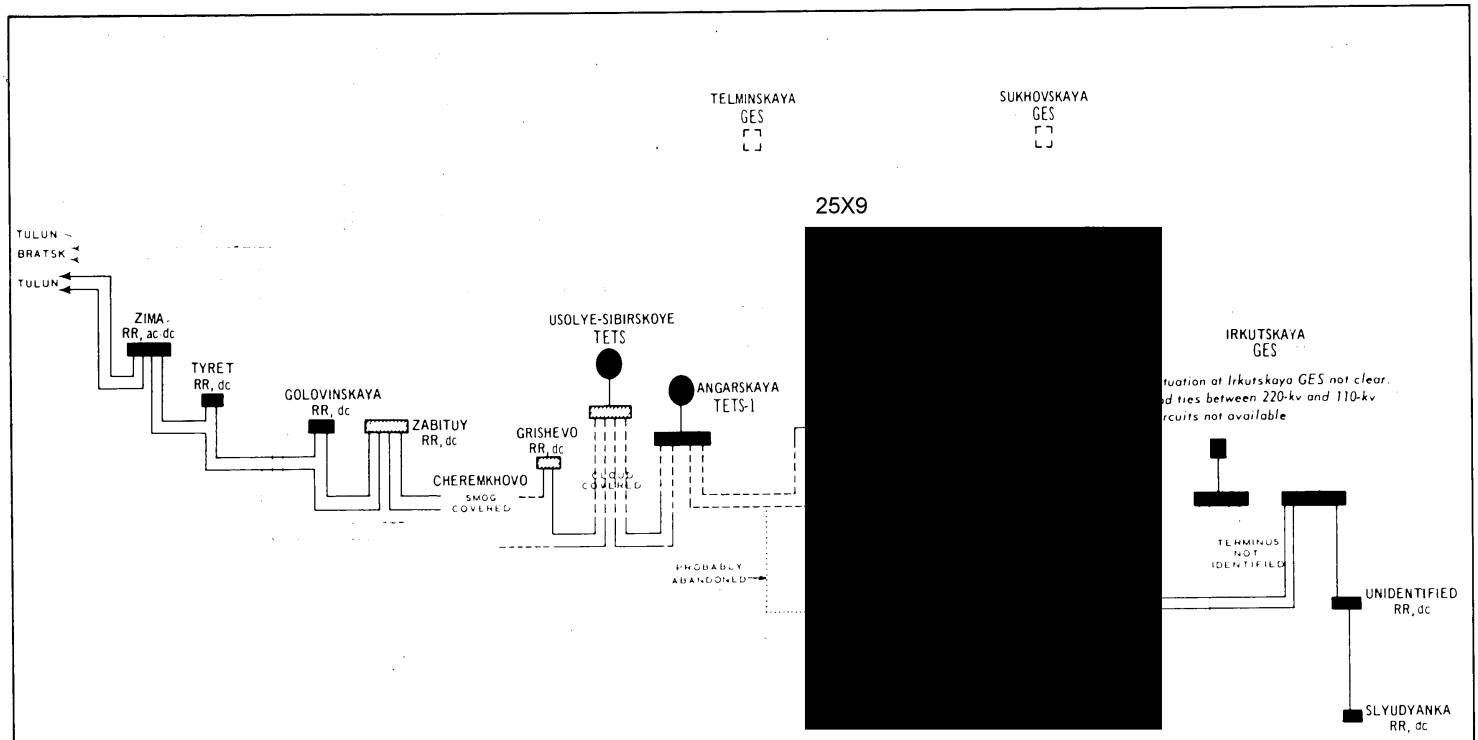
FIGURE 1. EAST-CENTRAL SECTION OF CENTRAL SIBERIAN POWER GRID. Planned connections outside the grid are not shown.



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[redacted]

RR, dc - Railroad substation, direct current

RR, ac-dc - Railroad substation, alternating and direct current

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